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SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Oyen Wiggs Green & Mutala LLP		
Signature			
Printed name	Gavin N. Manning		
Date	5 August 2005	Reg. No.	36,412

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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,416,366**, on December 16, 2002, by **CREO INC.**, assignee of Rob V. Bouchal and Mark D. McGaire, for "Sheet Removal & Conveying System".

Agent certificateur/Certifying Officer

November 21, 2003

Date

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ABSTRACT

In a device for handling sheets of imaging media in a stack, a picker bar for engaging the edge of a media sheet covers only a portion of the width of the sheet. The picker bar is rotated to shape the edge into a curve thus stiffening the edge so that it may be lifted away from the stack. The sheet, so engaged, may be conveyed or disposed of as required.

SHEET REMOVAL & CONVEYING SYSTEM

TECHNICAL FIELD

The invention relates to systems for handling flat sheets of media and more particularly to a system for holding and conveying a sheet from a stack of sheets.

BACKGROUND

Plates, films and proofing media for imaging systems, such as those used in the graphic arts industry, are commonly stacked in boxes with slip-sheet sheets interspersed between adjacent media sheets. The slip-sheet primarily functions to protect the media surface from damage and to prevent adjacent media sheets from adhering to each other. The slip-sheet is particularly important when the active emulsion of the media is either sticky or particularly sensitive to damage.

In the development of media for imaging tasks, particularly plates for lithographic printing operations, a number of often conflicting parameters such a print run length, exposure sensitivity, exposure latitude and processing requirements must often be traded off against one another to achieve best results. Some media have particularly good performance in relation to the abovementioned parameters but suffer from extreme delicacy of the un-exposed media emulsion. In a specific case, LH-PI lithographic plates supplied by Fuji Photo Film Co. Ltd. of Tokyo, Japan, have a particularly delicate

emulsion and may be scratched even by the action of removing the slip-sheet. However, once exposed, the emulsion is durable and the plate has good imaging and on-press performance.

Other commonly available media may have similar problems with delicate emulsion surfaces although, depending on the thickness and particular characteristics of the emulsion, scratches may or may not remain visible after subsequent processing. While not all media require special attention be paid to how slip-sheets are removed the problem has been evident in a number of media products supplied in the graphic arts industry.

In US patent 5,655,452 to Blake et. al. a slip-sheet removal mechanism for removing a slip-sheet from a plate is described. Briefly, the removal operates by activating a peeler airflow to initiate separation between the slip-sheet and the plate. A number of suction tubes are pivoted to above the slip-sheet and the stack of plates moved to engage the slip-sheet and the suction cups. A combination of movement of the plate stack and pivoting of the suction cups is used to separate the slip-sheet and move it towards a pair of nip rollers that complete the removal operation.

There remains a need for better methods of handling slip-sheets and there is a particular need for such a slip-sheet removal mechanism that performs the removal without any damage to the media emulsion.

SUMMARY OF THE INVENTION

In a first aspect of the present invention a method of removing a sheet from a stack of sheets involves engaging the edge of the sheet along a portion of its width with a picker bar, shaping the edge of the sheet by moving the picker bar and conveying the sheet to a new location.

In another aspect of the present invention an apparatus for removing a sheet from a stack has a moveable picker bar extending over a portion of the width of the slip-sheet and has one or more engagement structures for engaging the sheet near an edge and shaping the edge to increase its stiffness.

For an understanding of the invention, reference will now be made by way of example to a following detailed description in conjunction with accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In drawings which illustrate by way of example only preferred embodiments of the invention;

FIG. 1-A is an isometric view of a stack of media with a slip-sheet on the top media sheet and a picker bar in place ready to remove the slip-sheet.

FIG. 1-B is an enlarged isometric view of the picker bar, rotated to show the engagement structures on the underside.

FIG. 2-A to 2-E depict a series of steps in removing a slip-sheet using the picker bar of the present invention.

FIG. 3 is a side view of an alternate embodiment of the invention using a circular section picker bar.

FIG. 4 is a perspective view of an embodiment of the invention wherein an additional air-jet is used to enhance the operation of the slip-sheet removal system.

DESCRIPTION

Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification and the drawings are to be regarded in an illustrative rather than a restrictive sense.

This invention is described in relation to a novel slip-sheet removal system that is able to remove a slip-sheet from a media without damaging the delicate emulsion. The method of removal of the present invention specifically avoids causing relative movement between the slip-sheet and the media emulsion. While of particular application in removing slip-sheet from a stack of media in a graphic arts imaging system, the method and apparatus of the present invention may be useful in handling any type of media particularly where the

media is delicate and susceptible to damage. The term "media" should be read to include all manner of media used in imaging and printing operations.

Slips-sheets are commonly flimsy sheets of paper but may also be plasticised or other specially treated sheets depending on the media in use. In particular, lithographic plates are typically shipped in boxes of 25 or more plates with thin paper slip-sheets interspersed between plates. In an automatic plate handling system the stack of plates are commonly placed in an access position from which they are loaded onto the imaging engine by some manner of automated handler. The slip-sheets represent a problem for automatic media handling in that they must be removed prior to imaging. The removal is often complicated by electrostatic attraction between the sheet and the media surfaces. Because the slip-sheet is in intimate contact with the surface of the media a removal mechanism should also allow for the ingress of air under the slip-sheet as it is removed. The slip-sheet removal mechanism has the task of reliably separating the sheet from the plate and removing it to a location where it can be disposed of. It has been observed by the inventors of the present invention that emulsion damage may occur during slip-sheet removal whenever the edges are dragged or the material is bunched up and/or creased. During the slip-sheet removal process, the shearing action between the slip-sheet and the plate becomes localized to these creased areas and scuffing or scratching may occur. Further, it has been determined that if the slip-sheet can be engaged without forming creases so that it remains

in a flat sheet, and the engaged sheet can be lifted away from the media in substantially this condition scuffing may be completely avoided.

One possible solution is to engage the edge of the slip-sheet with an extended picker bar, either with a plurality of suction cups or a vacuum groove distributed over substantially the entire length of the sheet. While this solution has been found to work adequately there are some problems. Firstly, imaging systems typically accommodate a wide variety of media sizes and the bar would have to be the full width of the largest media used. For smaller media sizes the bar overlaps the edges causing problems with vacuum escapement where there is no slip-sheet material to engage. This problem can be addressed by providing zoned vacuum delivery albeit at higher cost and complexity. Secondly, the length of the bar for Very Large Format (VLF) size imaging devices becomes almost unmanageable and overly expensive since it must be made sufficiently rigid so as not to deform during actuation.

An embodiment of the present invention is shown in FIG. 1-A. A stack of media with slip-sheet interspersed 8 are shown in an access position. The autoloder device is not shown except for the slip-sheet removal components for sake of clarity. The top media sheet 10 (shown in cutaway view) in the stack 8 is covered by a slip-sheet 12. A picker bar 14 is shown in position to engage the slip-sheet 12 at one edge. While in an automatic system the stack may comprise a plurality

of media sheets, a manually loaded system may only have one media sheet in an access position.

One possible embodiment of picker bar 14 is shown in FIG. 1-B. The picker bar shown generally at 14 comprises a rigid angled frame 2 with a plurality of compliant suction cups 18 on the face for engaging the slip-sheet. Vacuum is supplied to the suction cups 18 via a number of vacuum lines 6. The suction cups 18 engage the slip-sheet when a vacuum source (not shown) is connected to the end of line 5. Advantageously a plurality of small diameter suction cups are used which reduces the possibility of the slip-sheet being deformed under the cups and thus forming creases that may scuff the emulsion. It was experimentally determined that suction cups purchased from Anver Corp of Hudson MA, model PFA7 part number 21700004, with a face diameter of around 7 mm worked particularly well. Suction cups 18 may be made from a compliant material or simply suction holes formed directly in the frame. The vacuum may be applied directly or indirectly by using Bernoulli effect holes. Alternatively, a longitudinal vacuum groove may be formed in the frame 2 to distribute the vacuum over a larger area. Mechanical fingers may also be used to pick and hold the slip-sheet, but for extremely delicate media there will be a higher risk of scuffing the emulsion.

As can be seen in FIG. 1-A the picker bar only engages the central area of one edge of the slip-sheet. The method of operation of the picker bar will be further explained with reference to FIG. 2A-2E. For sake of clarity the actuator mechanisms for moving the bar

towards the slip-sheet and for rotating it into engagement with the slip-sheet are not shown in the drawing figures since such mechanisms are well known in the art. Referring now to **FIG. 2-A**, initial engagement with the slip-sheet is with the heel **16** of the picker bar frame. At this stage, the suction cups **18** are still oriented away from slip-sheet **12**. It may be necessary to add a compliant padding to the heel **16** of frame **14** to ensure that it does not scuff the plate **10** through the slip-sheet **12**. The rear of the heel can also be curved to reduce scuffing, and the padding may extend around the curved portions of frame **14** as well. In the drawing figures, the gap between the slip-sheet **12** and the media **10** is exaggerated for clarity but in reality, the slip-sheet **12** rests on the plate.

In **FIG. 2-B** the suction cups **18** on bar **14** are rotated in a direction shown by arrow **19** into engagement with slip-sheet **12** whereafter a vacuum source (not shown) is connected to suction cups **18** to secure the slip-sheet to the picker bar. The vacuum may be generated using any known convenient means and may be applied by electrically activating a vacuum source or by opening a electromechanical valve or a combination of both. The vacuum may be applied before the suction cups engage the slip-sheet but applying it after the cups are in contact is preferred. Referring now to **FIG. 2-C**, once the slip-sheet **12** is held by the suction cups **18** the picker bar is rotated back in the direction shown by arrow **20**. This rotation causes the slip-sheet to lift off the plate **10** while simultaneously curling the edge. The curling of the slip-sheet edge, shown in

perspective view in FIG. 2-D, offers a substantive advantage over simply lifting the slip-sheet 12 directly off the plate. Firstly, any attempt to lift the slip-sheet directly from the position shown in FIG. 2-B will likely cause the sheet to bunch and crease when the portion held by the picker bar 14 is pulled. The outer edges (shown at 21 in FIG. 2-B) may still adhere to the media 10 until the electrostatic forces are broken and air ingress releases the slip-sheet. Under these conditions, creases may form and the media emulsion may be scuffed. Secondly, the force needed to peel the slip-sheet away in a curling motion is less than that required for direct lifting. In essence, introducing the curl compensates for the fact that picker bar 14 does not extend over the entire width of the slip-sheet 12 by forming an at least partially rigid edge before lifting it. It also provides an edge, along which the attractive forces are at least partially reduced thus facilitating further partial or complete peeling allowing eventual complete removal of the sheet without introducing creasing or bunching. The amount of curl may be 90° as shown or greater; larger curl typically providing a progressively stiffer edge. On the other hand, a curl of less than 90° may also be acceptable depending on the width and materials of the slip-sheet and the media.

Once the stiffened edge is formed, the slip-sheet may be peeled off the plate as shown in FIG. 2-E by one of or a combination of movement in the directions shown by arrows 24 and 26. The curled edge prevents the outer edges from falling back and scuffing the media

emulsion. As the slip-sheet is peeled back, an edge 28 continues to propagate allowing the electrostatic and other forces to be broken along the width of the slip-sheet, thus avoiding creasing or bunching. The slip-sheet thus at least partially removed may be passed on to a disposal mechanism such as the slip-sheet compactor described in commonly assigned US provisional patent application 60/393657 by Williams.

The present invention is not limited to handling slip-sheet material but may also be employed to handle any flimsy media using a picker bar that is shorter than the width of the media. In particular, graphic arts film and colour proofing media commonly comprise an emulsion on a thin sheet of polyester that may suffer either emulsion damage or creasing during handling. The loading of a flimsy media that has delicate emulsion may prohibit engaging the emulsion side or sliding the emulsion over the back of another sheet. If the media sheets are stacked emulsion side down the picker bar may engage the rear surface of the sheet and peel it back so that there is substantially less slippage between adjacent sheets. The picker bar may be used in a fully automatic system where the sheet is picked from a plurality of sheets in a stack or it may be used in a semi-automatic position where a single sheet is placed in an access position to be automatically loaded into the imaging device. Likewise, the same picker bar may be used to convey the sheet from the imaging device on completion of imaging.

In an alternative embodiment, the picker bar may be constructed using a circular section shown in FIG. 3. The circular section picker bar 30 allows the edge of slip-sheet 12 to be curled to form an edge in the shape of a partial tube and may be advantageous since a curled tube's stiffness will be consistent in more directions than other shapes. Furthermore the circular section bar may be made from common bar or tube stock whereas the angled bar shown in the drawing figures may have to be custom fabricated.

Actuators suitable for placing the picker bar on the sheet and rotating to engage the suction cups are well known. Pneumatic actuators, motors, stepper motors or servomotors may be used. Typically, the actuation functions required include a translation to place the picker bar on the slip-sheet and an actuation to rotate the bar into engagement. The rotation may be supplied by a separate actuator or the bar may simply be allowed to roll to bring the suction cups into engagement. The rotation of the picker bar may also be synchronized to the forward and backward movement of the picker bar to eliminate the possibility of the slip-sheet being slid forward over the media emulsion when the bar is rotated to engage the suction cups as shown in FIG. 2-B. If the shearing friction between the slip-sheet and the media emulsion or other sheets in the stack is low, this may be addressed by actively rotating the picker bar when engaging the engagement structures rather than just allowing it to roll forward. On the other hand, if the shearing friction is consistent and the slip-sheet does not slide easily a separate actuator may be

eliminated. Alternatively, the bar & suction cups may be lowered directly into engagement without the requirement of a further rotation.

In another embodiment shown in FIG. 4, one or more air jets 40 may be provided to assist in introducing the curl, should a kink 42 form in the edge of the slip-sheet. The air jet 40 may be blown along the slip-sheet 12 to snap the edge into the desired shape. The direction of the air jet 40 is only one example of many possibilities, including multiple air jet directions at the same time, or sequenced air jets. Air jet 40 may be mounted on picker bar 14 or may be separately mounted.

Once the curl is formed in the edge of the sheet and a propagating edge is established (as described in relation to item 28 of FIG. 2-E), the sheet may be removed in either direction. The sheet may be folded over itself and removed in a direction towards the opposite edge of the stack from the edge that was engaged. Alternatively, the sheet may be slid off in a direction away from the stack, lead by the curled edge.

While the shape for stiffening the front edge of the slip-sheet has been described as a "curl" in this description, it may be any of a variety of shapes including but not limited to a "V" shape, sine wave shape. Furthermore, the shape may or may not include a creasing of the edge to increase stiffness. Such creasing would not be a problem if performed once the slip-sheet if lifted away from the media. The

curl described herein has the advantage of being easy to create and has a low chance of scuffing the media. Accordingly, the term "curl" is used herein to describe any shape that is given to the edge of the slip-sheet or media with the intent of stiffening.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof.

WHAT IS CLAIMED IS:

1. A method of removing a sheet from a stack comprising steps of:

   a) engaging an edge of the sheet along only a portion of its width with a picker bar;

   b) shaping the edge of the sheet by moving the picker bar;

   c) conveying the sheet to a new location.

2. The method of claim 1 wherein the sheet is a slip-sheet interspersed between adjacent media sheets in a stack.

3. The method of claim 2 wherein in a further step the slip-sheet is transferred to a slip-sheet compactor for disposal.

4. The method of claim 1 wherein the media sheet is one of a lithographic or a flexographic plate.

5. The method of claim 1 wherein the sheet is a media sheet in a stack with slip-sheets interspersed between adjacent media sheets.

6. The method of claim 1 wherein the movement of the picker bar is a rotation about a longitudinal axis.

7. The method of claim 1 wherein the edge is engaged by rotating the picker bar in a first direction to bring the picker bar into engagement with the sheet and then rotated in an opposite direction to form the curve along the edge of the sheet.

8. The method of claim 1 wherein the conveying step comprises at least partially peeling the sheet away from the underlying stack and then sliding the rest of the sheet off in a direction away from the stack such that the removal is lead by the curled edge of the sheet.

9. The method of claim 1 wherein the conveying step comprises peeling the sheet away from the underlying stack in a direction towards the opposite edge of the sheet from that which is engaged by the picker bar such that the sheet at least partially folds back over on itself.

10. An apparatus for removing a sheet from a stack comprising a moveable picker bar extending over a portion of the width of the sheet, the picker bar having one or more engagement structures for engaging the sheet near an edge and shaping the edge to increase its stiffness.

11. The apparatus of claim 10 wherein the engagement structures are one or more suction cups.

12. The apparatus of claim 10 wherein the engagement structures are one or more vacuum grooves extending longitudinally along the picker bar.

13. The apparatus of claim 10 wherein the engagement structures are one or more mechanical fingers disposed to grasp and shape the edge of the sheet.

14. The apparatus of claim 10 wherein one or more air jets are directed towards the vicinity of the edge to assist in shaping the edge.

15. The apparatus of claim 10 wherein the picker bar is moved by an actuator that places the bar in contact with the sheet proximate to the edge, rolls the bar towards the edge to engage the sheet and then lifts the sheet away from the stack.

16. The apparatus of claim 10 wherein:

a) the picker bar is moved by a first actuator that places the bar in contact with the sheet proximate to the edge;

b) a second actuator rotates the bar towards the edge to engage the sheet, the rotation of the second actuator being synchronised with the motion of the first actuator so that substantially no shearing force is imparted to the sheet.

17. An apparatus for removing a sheet from a stack comprising:

a) means for engaging an edge of the sheet;

b) means for shaping the engaged edge of the sheet;

c) means for conveying the sheet to a new location;

whereby the shaped edge of the sheet stiffens the leading edge to facilitate removal.

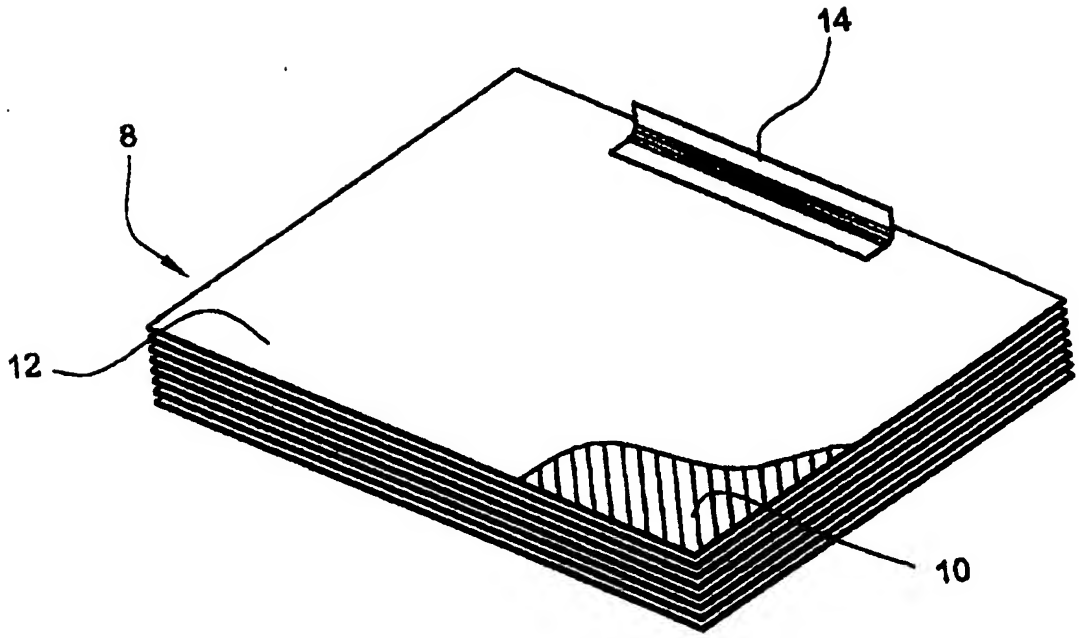

FIG. 1-A

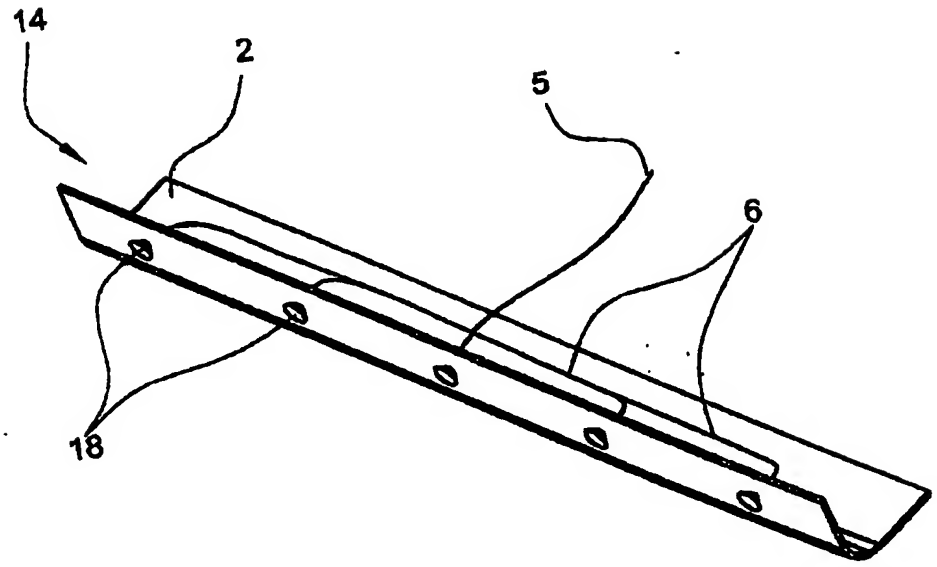

FIG. 1-B

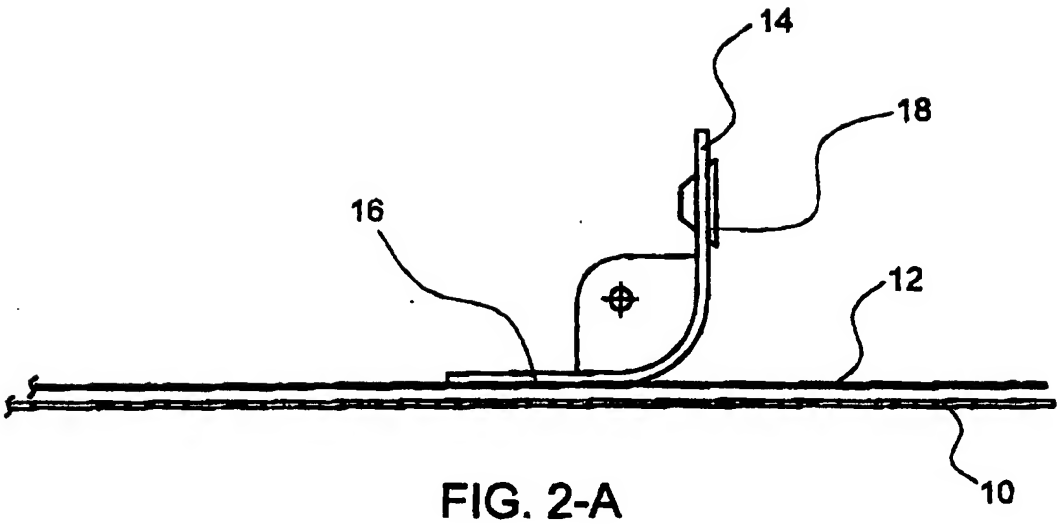

FIG. 2-A

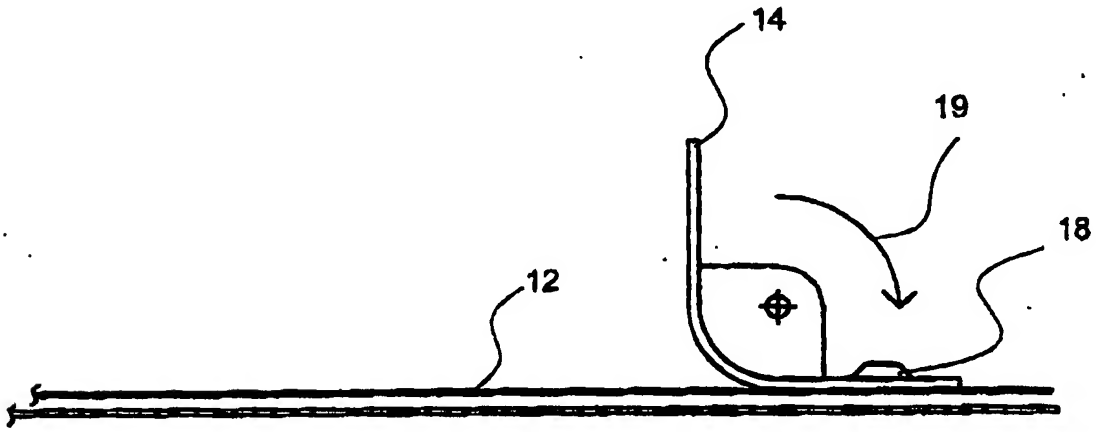

FIG. 2-B

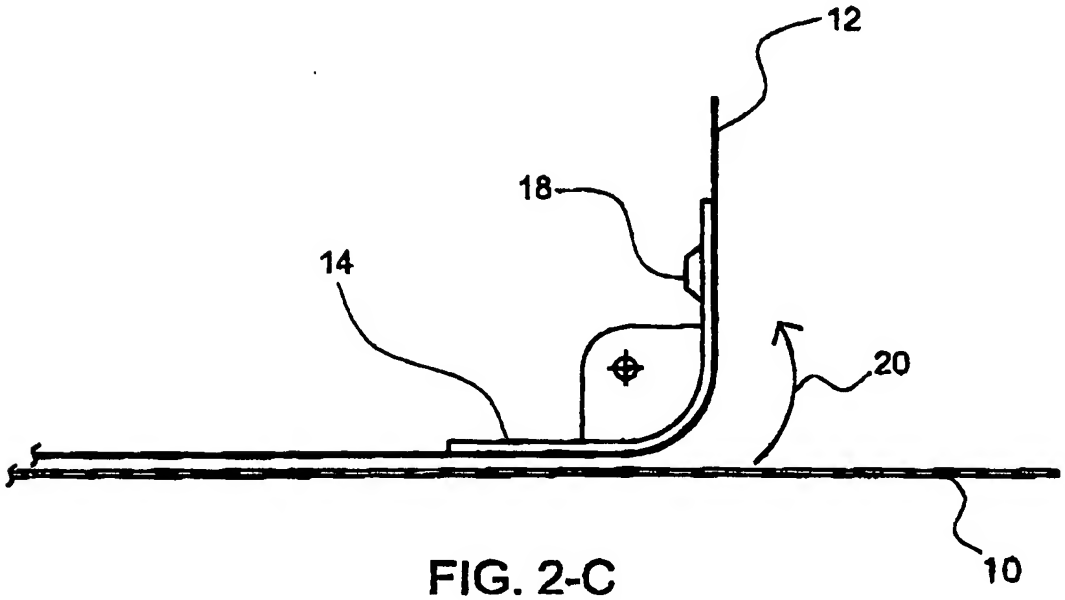

FIG. 2-C

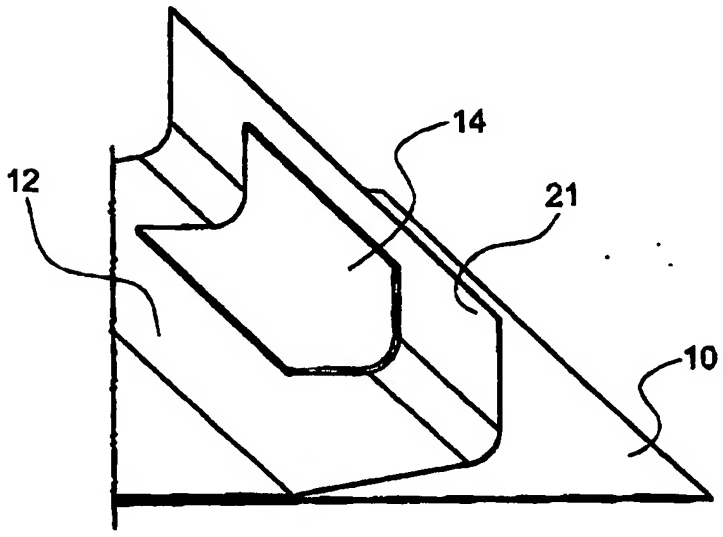

FIG. 2-D

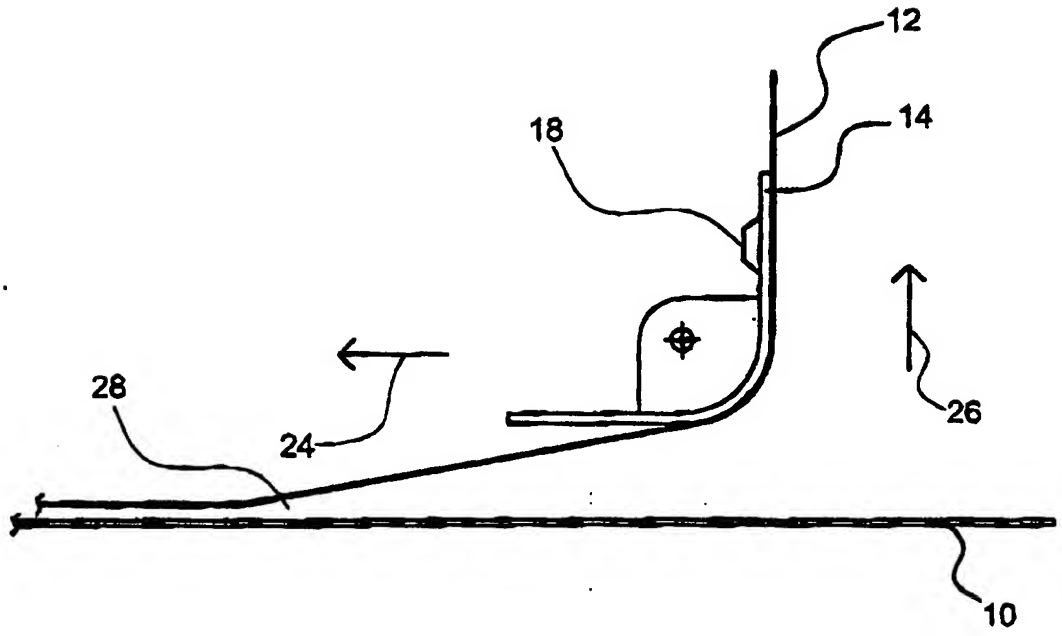

FIG. 2-E

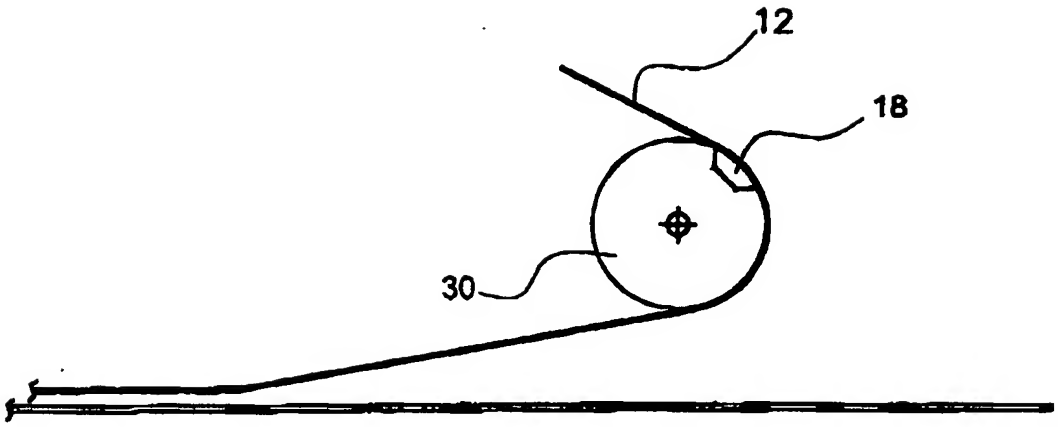

FIG. 3

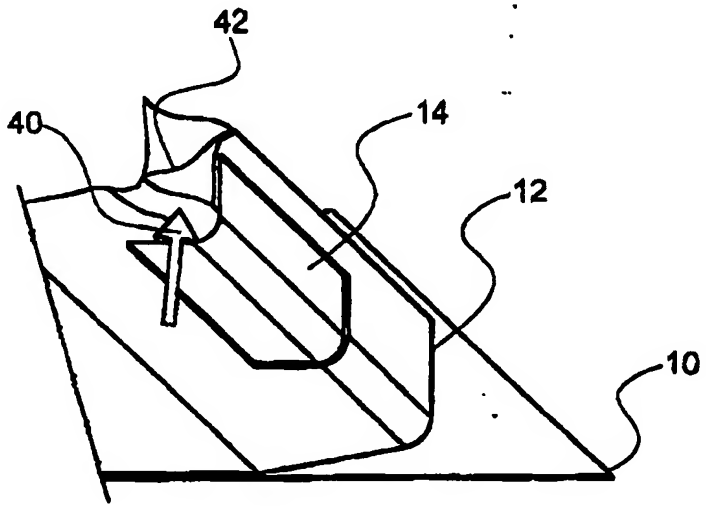

FIG. 4